Size reduction technique for microstrip patch antenna

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A compact microstrip patch antenna for 5 GHz is proposed. It presents the very small size at resonance (5 GHz), which represents a surface reduction of 60% compared with a conventional microstrip patch antenna. The branch line coupler is used for 90^0 phase shift between two vertical feed and equal power coupling. The proposed antenna exhibits a gain of 5.1 dBi to 5.5 dBi for E-plane in the range of its bandwidth, which is 60 MHz.

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1. Introduction

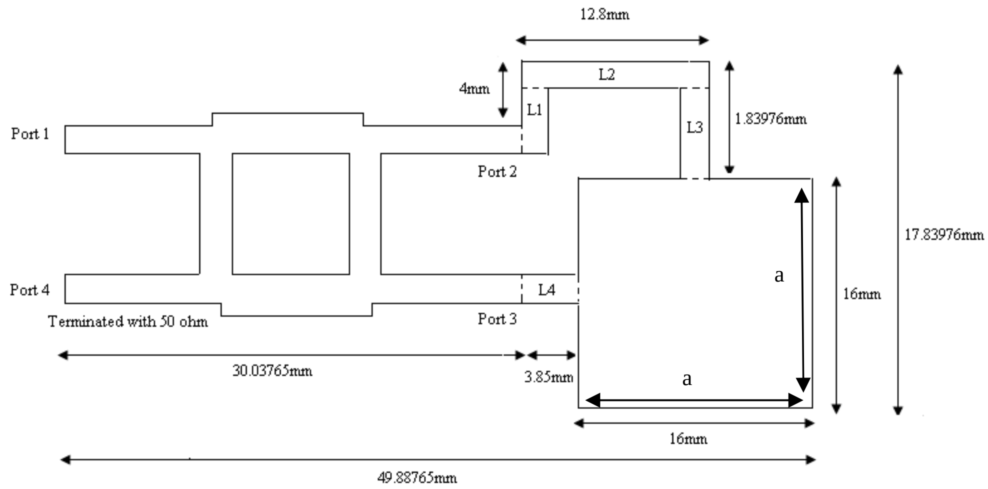
Microstrip antenna have many unique and attractive properties such as low in profile, light in weight, conformable in structure, compact and easy to fabricate and to be integrated with solid-state devices [1]. Microstrip antennas have found wide applications in radio systems with single-ended signal operation. Recently, microstrip antennas can be use in radio systems, with differential signal operation as well [2],[3]. One such antenna, the circularly polarized microstrip patch antenna is often exploited in mobile terrestrial and satellite communication terminals. To accomplish the need of high performance devices, there is a great need for compactness of circuits and antennas. This include the use of high dielectric constant substrate [4], short-circuiting the patch to ground plane and modifying the geometry of the patch [5]. In this paper, the design and implementation of a dual fed circular polarization rectangular microstrip patch antenna using microstrip line feeding is introduced. The proposed antenna is both theoretically and experimentally investigated. We present the performance of the antenna circularly polarized and the radiation pattern for both H-plane and E-plane.

2. Proposed antenna design

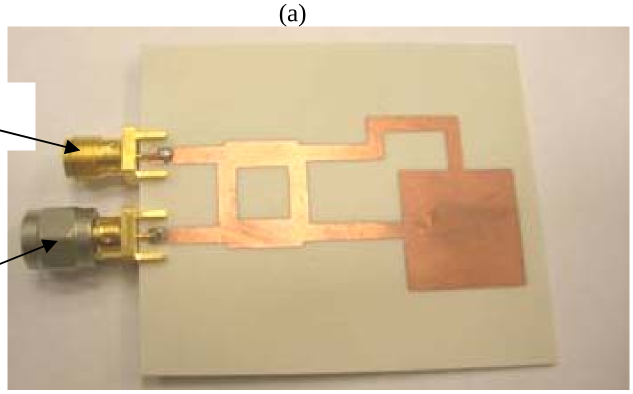
The proposed circularly polarized microstrip patch antenna and its feeding coupler are shown in Fig. 1. The quadrature (90^0) hybrid (3 dB) coupler generates orthogonal modes for circular polarization. There are two microstrip feed lines in the design as shown in Fig. 1. The first feed line is used to connect port 2 of the coupler to the center of the length of the antenna. It is comprised of three microstrip lines that are L1, L2 and L3. The second feed line was used to connect Port 3 to the center of the width of the antenna which is L4. The feed lines were connected to the two adjacent edges of the rectangular microstrip patch antenna so that circular polarization could be obtained. The antenna is mounted on an ROGERS (RO4003C) substrate with dielectric constant of 3.38 and thickness of 31 mil.

3. Results and discussion

Fig. 2 shows the measured and simulated S_{11} that indicates how well the antenna is matched to a signal source and how wide the impedance bandwidth is. The impedance bandwidth is the difference between the upper and lower frequencies for which S_{11} is less than or equal to -9.5 dB (or VSWR less or equal to 2). The measured impedance bandwidth is 60 MHz. In the range from 4.97 GHz to 5.03 GHz, the antenna exhibits return losses lower than -10 dB and at 5 GHz the return loss is at -30 dB which represents good matching characteristics. An Agilent network analyzer was used to measure S_{11}, an HP network analyzer the radiation patterns and an Agilent signal generator and an HP spectrum analyzer the gain in an anechoic chamber. The agreement between the measured and simulated results is in general acceptable. Figs. 3 and 4 show the simulated and measured radiation patterns of microstrip patch antenna at 5 GHz. It is observed that a good agreement is obtained between the simulation and measurement. The front-to-back ratio is 19.2 dB for the E-plane and 24.3 dB for the H-plane. The cross-polarization level is lower than -25.2 dB for the E plane and -26.1 dB for the H-plane. Fig. 4 shows the measured gain of the bandwidth of 60 MHz corresponds to the -10 dB response curve frequency range shown in Fig. 2. The peak gain was measured with the approach of two identical antennas. The measured peak gain values at 5 GHz are 5.5 and 5.6 dBi for the E-plane and H-plane, respectively. In the range of the frequency bandwidth, the gain of the antenna varies between 5.1 dBi to 5.5 dBi for the E-plane and between 5.2 dBi to 5.6 dBi for the H-plane. The antenna exhibits the compact overall size of 49.8 mm × 18 mm, which corresponds to a surface reduction of about 60% in comparison with a conventional microstrip patch antenna.



(a)



(b)

Fig. 1. (a) Proposed compact circularly polarized microstrip patch antenna connected to a 3-dB 90 degree coupler, (b) Fabricated microstrip antenna.

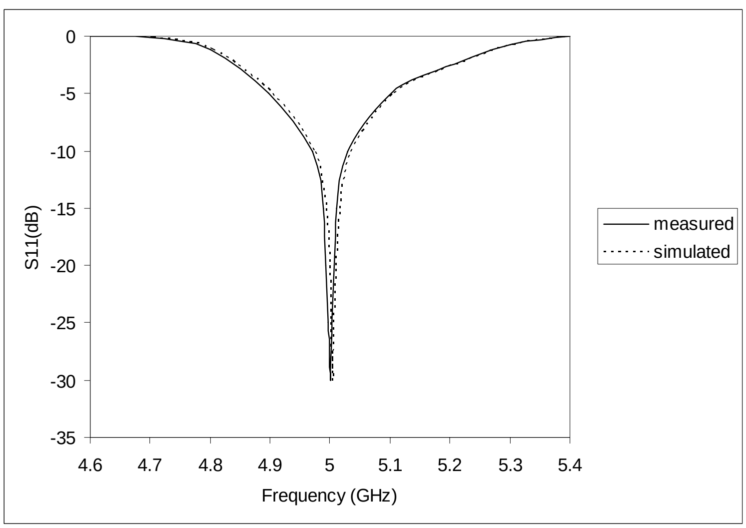


Fig. 2. Simulated and measured S_{11} versus frequency of the proposed microstrip antenna.

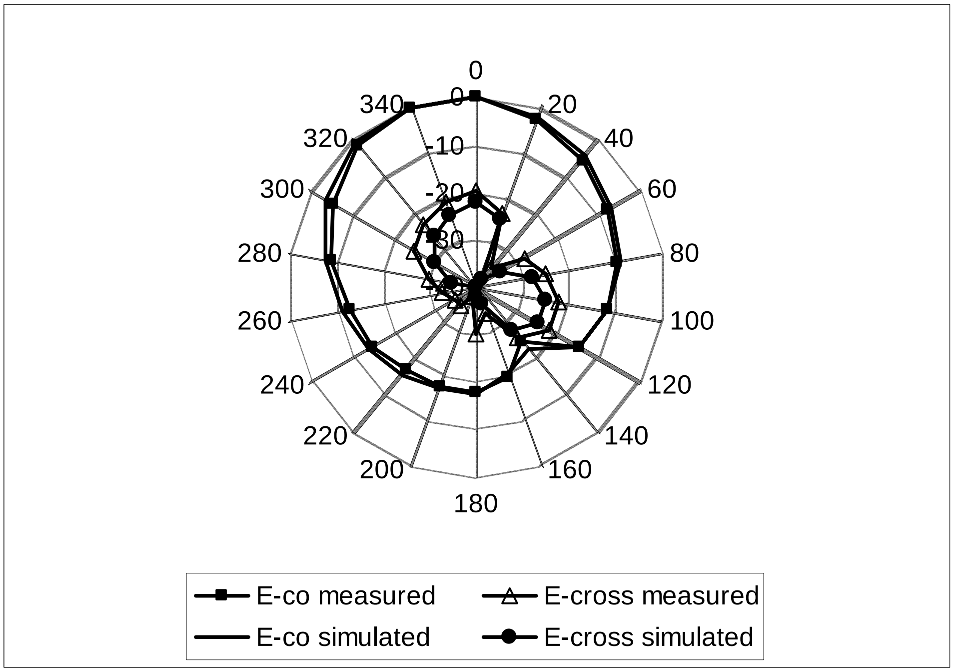


Fig. 3. Simulated and measured radiation patterns at 5 GHz for E-plane.

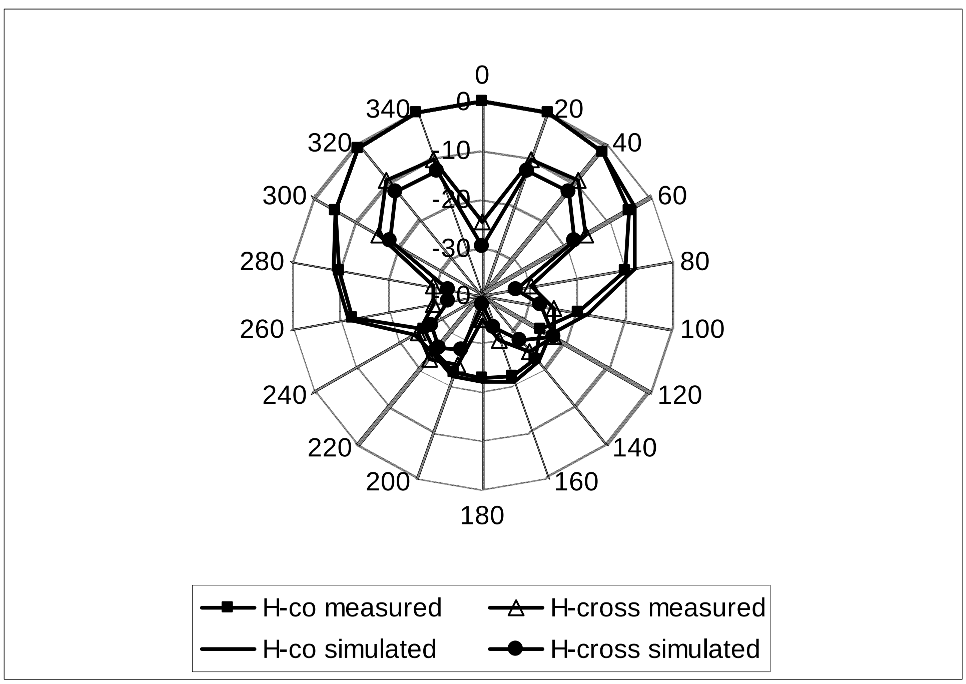


Fig. 4. Simulated and measured radiation patterns at 5 GHz for H-plane.

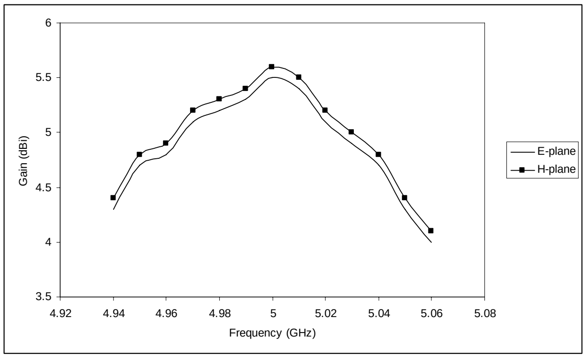


Fig. 5. Measured gain (the bandwidth of 60 MHz corresponds to -10 dB isolation frequency range shown in Fig. 2).

3. Conclusions

A compact circularly polarized microstrip patch antenna has been proposed and demonstrated. The antenna is characterized by a size reduction of 60% when compared to a conventional microstrip patch antenna. This structure should find applications in compact phased arrays due to its small size and integration of the feedline in the plane of the antenna.

References

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